

## **REMARKS**

The present amendment is in response to Paper No. 2, the Office Action mailed February 21, 2003, in which Claims 1 through 20 were rejected. The Applicant has thoroughly reviewed the outstanding Office Action including the Examiner's remarks and the references cited therein. The following remarks are believed to be fully responsive to the Office Action and, when coupled with the above amendments, are believed to render all claims at issue patentably distinguishable over the cited references.

The drawings, specification and Claims 1-20 are amended to make the claims definite, positively supported by the specification, and patentable over any one of Appelt et al., Yedur et al., or Pierrat. The amendments do not change the scope of the claimed invention as originally filed. Further, the corresponding parts of the figures are also amended. Indisputably, no new matter is raised.

### **Specification Amendment**

The Applicant amended the specification to be in proper idiomatic English. The amended specification contains no new matter.

### **Claim Amendment**

With respect to Paragraph 5 of the Office Action, the Examiner rejected Claims 1-20 under 35 U.S.C. 103(a) because the claimed invention is unpatentable over any one of Appelt et al., Yedur et al., or Pierrat.

A new wording "being effective attached to said patterned photoresist" is inserted after "an additional material" in Claims 1, 14, and 18. A wording "patterned" is inserted before the "photoresist" in Claims 1, 14, and 18 and other Claims. It is respectfully submitted that these amendments are supported by the specification and the drawings as filed.

Specifically, FIGS. 2A-2D indicate that the patterned photoresist layer (21) is formed and patterned on the surface of a substrate (20). The Summary of the Invention further recites that "another main object of this invention is to improve precision of pattern of photoresist without changing photoresist material or changing both develop process and bake process;" and the Description of the Prior Art narrates that "trenches are ... in formed photoresist which is patterned ... FIGS. 1A and FIG. 1B illustrate ideal shape of patterned photoresist..." It is further respectfully submitted that the purpose of the above amendments is to make the claim term (i.e., photoresist) more definite throughout Claims 1-20. The amendments do not change the scope of the claimed invention as originally filed.

#### Rejection of Claims 1-20— In General

The Applicants have carefully analyzed the differences between the present invention and Appelt et al., Yedur et al., or Pierrat and request reconsideration and withdrawal of the rejection.

Rejection of Claims- 35 U.S.C. SECTION 102(e)

The Examiner states that Claims 1-20 are rejected under 35 U.S.C. 102(e) by Appelt et al, because the claims are shown, described and taught by the prior art reference.

The Applicant carefully analyzed what Appelt discloses, and the rejection is respectfully traversed on the basis that what Appelt discloses is different from the subject matter of the claimed invention.

Because the photoresist of the claimed invention is processingly treated whereas Appelt uses photoresist to treat the circuit board, these two inventions are related to different subject matter. Appelt is directed to a process for filling apertures in a circuit board or chip carrier with a photosensitive dielectric material. To the contrary, the preamble of present Claim 1 defines "a method for reducing line edge roughness of photoresist" in which material is filled in "said trenches" of the "patterned photoresist". All of these amount to saying that the patterned photoresist layer is subjected to be processed (i.e., to be filled) in the claimed invention, rather than the circuit board is subjected to be processed using photoresist material as in Appelt. Thus, Appelt does not anticipate Claims 1-20.

The rejection is further traversed because Appelt does not disclose each element of the claimed invention. Appelt fails to disclose "filling said trenches of a patterned photoresist, said trenches being totally filled by an additional

material" as in Claims 1, 14, and 18. Appelt discloses " filling the apertures in the circuit board or chip carrier ...". See Claims 1 and 17 of the reference.

So, reconsideration and withdrawal of the rejection under 35 U.S.C. 102(e) is respectfully requested.

Rejection of Claims- 35 U.S.C. SECTION 103(a)

The Examiner states that Claims 1-20 are rejected under 35 U.S.C. 103(a) as being unpatentable over any one of Appelt et al., Yedur et al., or Pierrat.

The Applicant respectfully requests reconsideration and withdrawal of this rejection.

The claimed invention which is related to wafer treatment is nonobvious over Appelt because the cited prior art relates to an entire different field i.e. circuit board or chip carrier which is non analogous art. Appelt discloses an aperture filling layer supported on a carrier film and filling apertures in a circuit board or chip carrier with dielectric material. All Appelt teachings belong to repair of a circuit board or chip carrier, while the claimed invention pertains to the fabrication of a patterned photoresist. Specifically, Appelt provides a process for filling apertures in a circuit board or chip carrier with a dielectric material along with the ability to achieve a planar surface that avoids introducing dimensional changes and does not adversely impact the dimensional stability of the printed circuit board or chip carrier, while the

claimed invention, i.e., the patterned photoresist exposure/development technology, is related to the material properties of the patterned photoresist and their subsequent processing technology by which the patterned photoresist is lithographically exposed. As filling apertures in a circuit board or chip carrier and the patterned photoresist processing technology, respectively, belongs to distinct and separate processes in the semiconductor manufacturing, each pertains to different technical field. The reference of Appelt is not within the field of the Applicant 's endeavor. As a circuit board, or chip carrier, without any apertures is useless for "filling said trenches (of a patterned photoresist) ", Appelt is neither reasonably pertinent to the particular problem with which the inventor is concerned. Therefore, a person of ordinary skill, seeking to solve a problem of reducing defects in a patterned photoresist layer, would not reasonably be expected or motivated to look for a solution in Appelt.

The Examiner states that Yedur et al. and Pierrat established the prima facie nonobviousness of the claimed invention over the prior arts under 35 U.S.C. 103(a), because the two patents render it obvious to apply the mask repair techniques to photoresist. So the Examiner states, "This is motivated by the fact that mask imaging and repair closely follows basic photoresist /semiconductor processing steps and rules." The Applicant respectfully requests reconsideration and withdrawal of this rejection for the following reasons.

To establish a prima facie case of obviousness, three basic criteria must be met. First, there must be some suggestion or motivation, either in the

citations of Yedur et al. and Pierrat or in the knowledge generally available to one of ordinary skill in the art, to modify the citations of Yedur et al. and Pierrat or to combine reference teachings. Second, there must be a reasonable expectation of success. Finally, the prior art reference, the citations of Yedur et al. and Pierrat, must teach or suggest all the claim limitations. To support the conclusion that the claimed invention is directed to obvious subject matter, either the citations of Yedur et al. and Pierrat must expressly or impliedly suggest the claimed invention or the examiner must present a convincing line of reasoning as to why a person having ordinary skill in the art would have found the claimed invention obvious in light of the teachings of Yedur et al. and Pierrat.

There is no suggestion or motivation, either in the citations of Yedur et al. and Pierrat or in the knowledge to modify the references or to combine reference teachings. There is no reasonable expectation of success, and teaching or suggestion of all the claimed limitations. Therefore, the Applicant respectfully and resolutely suggests that Examiner should not conclude the claimed invention is unpatentable over two patents of Yedur et al. and Pierrat.

Because the claimed invention belongs to a different field from Pierrat's invention, the claimed invention is nonobvious over the patent of Pierrat. Pierrat refers to depositing and trimming the defective area of a reflective photomask by locally depositing material over the defective area. All Pierrat teachings belong to the repair of a reflective photomask, while the claimed

invention pertains to the fabrication of a patterned photoresist layer. The art of the claimed invention is different from the art of Pierrat.

Specifically the Pierrat technology, i.e. the photomask technology, is for providing imaging patterns on the wafer at desired line widths and line spacings, while the claimed invention, i.e., the patterned photoresist exposure/development technology, is related to the material properties of the patterned photoresist and their subsequent processing technology by which the patterned photoresist is lithographically exposed. The element, e.g. the photomask, that the Pierrat method processes is different from the element, e.g. the photoresist, that the claimed method processes.

As the photomask technology of Pierrat and the patterned photoresist processing technology of the invention, respectively, belong to distinct and separate processes in the semiconductor manufacturing, each pertains to different art.

The office's rejection on the ground of 103(a) is traversed because the Applicant's invention uses a plainer filling process than Pierrat's invention does, but achieves an unexpected result. The method of filling trenches of the present invention is described as "...method for filling trenches 22 with additional material 23 at least could be spin coating, dip, or spray." (page 6, line 18-20), and as "...filling said trenches with said additional material is chosen from the group consisting of spin coating, dip, and spray..."(Claim 7 and 19). The method of curing the defect of the defective layer 26 that Pierrat described includes "...deposited by a material deposition system 40. ... the deposition system 40 includes either one of a laser source or an ion

source...local deposition is performed using a patterning or lift-off process.” (Col. 6, line 7-15), “...depositing into the indentation characterizing the first defect a second material... under operating conditions of the lithographic semiconductor fabrication process...” (Claim 1, 5, 7 and 13), “...comprises laser assisted deposition.” (Claim 3 and 9), and “...comprises ion beam assisted deposition.” (Claim 4 and 10). When Pierrat wants to cure the defects of the photomask (the defective layer 26), he has to use a deposition system 49 including either a laser source or an ion source. The claimed invention is simpler with spin coating, dipping, and spraying the additional material to fill trenches. Even though Pierrat didn’t disclose every detail of the “deposition process” to deposit the second material onto the defects of the first material (the photomask), the “deposition process” as well known in the art should include depositing, lithography through a mask, developing and rinsing (or etching). The above steps of “deposition process”, disclosed by Pierrat to repair the reflective photomask, is more complicated than the method for reducing line edge roughness of patterned photoresist, disclosed and claimed by the Applicant. The claimed filling method is plainer and simpler with an unusual result, than the depositing method of Pierrat.

Furthermore, the office’s rejection on the ground of 103(a) is traversed because the Applicant’s material is not as restricted as Pierrat’s depositing materials, but achieves an unanticipated consequence. The properties of the materials and the enhance adhesion method for filling trenches of the patterned photoresist that the Applicant disclosed are different from the properties and adhesion method of Pierrat. The Applicant disclosed “... additional material for filling the trenches... are material which could be



adhered to patterned photoresist 21 by chemical reaction, such as chemical bonding, or by physical adsorption, such as capillary phenomena. Additional material 23 usually is fluid material, such as solution and/or suspension, to ensure all trenches are totally filled by additional material 23. Moreover, additional material 23 could be thermosetting polymer, thermoplasticity polymer, and/or any material which could be reacted with hydroxyl group or proton in patterned photoresist 21. Possible materials of additional material 23 at least include following: PMMA, POLY IMIDE, RELACS, material with a functional group of -NH groups, and material with a functional group of -OH groups.” (page 6, line 21-page, line 4, and Claim 4, 5, 6, 7, 8, 9, 10, 11, 12 and 13). Pierrat disclosed “...second material (material for filling defects of the first material) having substantially the same reflectivity and phase response... as the first material...” (Claim 1, 5, 7 and 13), and “...the first material and second material consist of the same material.” (Claim 2, 8 and 14). The materials of the claimed method of reducing line roughness of patterned photoresist and the materials of Pierrat for repairing photomask have diverse properties. The materials’ properties that the Applicant disclosed are not as restricted as the materials’ properties that Pierrat disclosed. Therefore, the different materials used by the claimed invention and Pierrat do not support the office’s finding of obviousness.

The office’s rejection on the ground of 103(a) is traversed because the Applicant’s removing process is more convenient than Pierrat’s trimming process, but achieves an unexpected result. The claimed method of removing the excess additional materials is chosen from the group consisting of thermal

treatment and spin, as shown in Claim 20. Pierrat trimmed the excess second material by focused ion beam milling as shown in Claim 6 of the reference, and disclosed trimming means that comprise an ion source for implementing focused ion beam milling as shown in Claim 12 of the reference. The removing method of the Applicant is non-obvious at the time the invention was made to a person having ordinary skill in the art.

Moreover, even patterning photoresist is performed through a perfect photomask, that doesn't include any defects, as Pierrat wished, the patterned photoresist may include trenches, that the Applicant wants to remove. Hence, the reference of Pierrat is not reasonably pertinent to the particular problem with which the inventor is concerned. Therefore a person of ordinary skill, seeking to solve a problem of reducing defects in a patterned photoresist layer, would not reasonably be expected or motivated to look for a solution in to Pierrat. Absolutely, the claimed invention is non-obvious over Pierrat.

The Yedur technology, i.e. the photomask technology, is for providing imaging patterns effectively on the wafer at desired line widths and line spacings, while the claimed invention, i.e., the patterned photoresist exposure/development technology, is related to the material properties of the patterned photoresist and the subsequent processing technology by which the patterned photoresist is lithographically exposed. The element, e.g. the photomask, that Yedur processes is different from the element, e.g. the photoresist, that the claimed method processes.

As the photomask technology of Yedur and the patterned photoresist processing technology of the invention, respectively, belong to distinct and

separate processes in semiconductor manufacturing, each pertains to different art.

The office's rejection on the ground of 103(a) is traversed because the Applicant's invention uses a plainer filling process than Yedur's invention does, but achieves an unexpected result. The method of filling trenches of the present invention is described as "...method for filling trenches 22 with additional material 23 at least could be spin coating, dip, or spray." at (page 6, line 18-20), and as "...filling said trenches with said additional material is chosen from the group consisting of spin coating, dip, and spray..."(Claim 7 and 19). The method of repairing the defects of the photomask that Yedur described includes "...to correct for such defects...the photomask 10 is introduced onto object stage 7 (FIG.5) of the STM 50." (Col. 6, line 5-7), "In order to deposit mask material, the tip 25 is caused to oxidize with certain molecules in the surrounding air so as to deposit an appropriate mask material at the location of the tip 95." (Col. 6, line 52-55), "...in order to form the material compatible with the film 20, the STM and photomask 10 are included in a chamber 128 in which there is a predetermined concentration of carbon atoms. Such carbon atoms react with the tungsten tip 95 upon application of the bias voltage to the tip 95 to produce opaque mask material to fill the voids in the film 20." (Col. 7, line 11-16), "...repairing defects in the at least one mask layer using a scanning tunneling microscope..." (Claim 1 and 5).

When Yedur wants to repair the defects of the photomask, he has to use a scanning tunneling microscope having a tip. The claimed invention is simpler with spin coating, dipping, and spraying the additional material to fill

trenches. Even though Yedur didn't disclose every detail of the "repairing process" to repair the photomask, the "repairing process" as well known in the art should include finding defects gradually. The repairing process, disclosed by Yedur, is more complex than the method for reducing line edge roughness of patterned photoresist, claimed and disclosed by the Applicant. When using the Applicant's filling method, it is not necessary to scan the defects on the patterned photoresist (even if there are defects on the photomask), it is sufficient to spin coat, dip, and spray the additional material to fill trenches. The claimed filling method is plainer than the repairing method Yedur disclosed.

The office's rejection on the ground of 103(a) is traversed because the Applicant's material is not as restricted as Yedur's depositing materials, but achieves an unexpected result. The properties of the materials and the enhance adhesion method for filling trenches of the patterned photoresist that the Applicant disclosed are different from the properties and adhesion method of Yedur. The Applicant disclosed "... additional material for filling the trenches... are material which could be adhered to patterned photoresist 21 by chemical reaction, such as chemical bonding, or by physical adsorption, such as capillary phenomena. Additional material 23 usually is fluid material, such as solution and/or suspension, to ensure all trenches are totally filled by additional material 23. Moreover, additional material 23 could be thermosetting polymer, thermoplasticity polymer, and/or any material which could be reacted with hydroxyl group or proton in patterned photoresist 21. Possible materials of additional material 23 at least include following: PMMA, POLY IMIDE, RELACS, material with a functional group of -NH groups, and material with a

functional group of -OH groups.” (page 6, line 21-page, line 4, and Claim 4, 5, 6, 7, 8, 9, 10, 11, 12 and 13). Yedur disclosed “...in order to obtain a suitable opaque material which is compatible with the chrome, the metal tip 95 and carbon molecules... are caused to react with reactive gases to deposit suitable material for repairing the defect. ... the deposited material may be carbon, chrome, or an amorphous silicon. ...”(Col. 6, line 64- Col. 7, line 2). The materials of the claimed method of reducing line roughness of patterned photoresist and the materials of the Yedur have diverse properties. The materials’ properties that the Applicant disclosed are not as restricted as the materials’ properties that Yedur disclosed. The Applicant’s invention uses less restricted materials than Yedur.

Furthermore, the office’s rejection on the ground of 103(a) is traversed because the Applicant’s removing process is more convenient than Yedur’s removing process, but achieves an unexpected result. The claimed method of removing the excess additional materials is chosen from the group consisting of thermal treatment and spin, as shown in Claim 20. Yedur removes excess material by scraping, probing or dragging the excess material with the tip portion as shown in Claim 1, 5, 7 and 16 of the reference. The removing method of the Applicant is non-obvious at the time the invention was made to a person having ordinary skill in the art.

Moreover, even patterning photoresist is performed through a perfect photomask, that doesn’t include any defects, as Yedur wished, the patterned photoresist may still include trenches, that the Applicant wants to remove.

Hence, the reference of Yedur is not within the field of the Applicant’s endeavor, and is not reasonably pertinent to the particular problem with which

the inventor is concerned; and a perfect photomask without any defects, as Yedur wants, is not usable to cure the defects on patterned photoresist, which must be cured by the claimed invention, i.e. by "filling said trenches (of a patterned photoresist) ". Therefore a person of ordinary skill, seeking to solve a problem of reducing defects in a patterned photoresist layer would not look for a solution in Yedur.

The claimed invention belongs to the line edge roughness of patterned photoresist. Pierrat belongs to repair of a reflective photomask. Yedur belongs to a method of repairing defects in a photomask used in the formation of semiconductor wafer includes the use of a scanning tunneling microscope. Appelt belongs to a planar surface that avoids introducing dimensional changes and does not adversely impact the dimensional stability of the printed circuit board or chip carrier. Summarily, Pierrat and Yedur relate to the defects in a photomask, Appelt relates to the surface of the printed circuit board or chip carrier, and the claimed invention is directed to fixing the line edge roughness of the patterned photoresist. Even if Pierrat repaired the reflective photomask defects by using locally depositing process and depositing materials over the defective areas, Yedur repaired the photomask by using a scanning tunneling microscope, and Appelt repaired the apertures in a circuit board or chip carrier by photosensitive dielectric material, respectively, the patterned photoresist may still have roughness or trenches. The claimed invention reduces line edge roughness of a patterned photoresist after the patterned photoresist is formed, but the above-cited references cannot reduce line edge roughness of a patterned photoresist.

The present invention, as claimed in amended Claims 1-20, is not obvious to one skilled in the art at the time the invention was made over Pierrat, Yedur or Appelt.

Thus, the Applicant most respectfully traverses the rejection in light of the amendment to the claims and for the reasons stated the above. That is, none of the cited references, (Pierrat, Yedur and Appelt), discloses or teaches/suggests to reduce the line edge roughness of a patterned photoresist, as recited in amended Claims 1-20. Therefore, the amended Claims (1-20) are not obvious to one skilled in the art at the time the invention was made over Pierrat, Yedur and Appelt, whether applied individually or in combination. Accordingly, amended Claims 1-20 are patentably distinguished over the above-cited references.

#### CONCLUSION

The Applicant submits that amended Claims 1-20 patentably distinguish over the cited references and are in condition for allowance. Accordingly, reconsideration and withdrawal of the rejections is most respectfully requested.

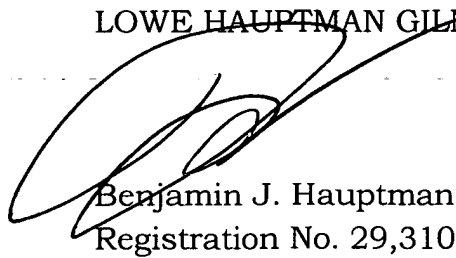
**Attached hereto is a marked-up version of the changes made to the specification, Abstract, drawings, and the claims by the current amendment. The attached paper is captioned "VERSION WITH MARKING TO SHOW CHANGES MADE"**

To the extent necessary, a petition for an extension of time under 37 C.F.R. 1.136 is hereby made. Please charge any shortage in fees due in connection

with the filing of this paper, including extension of time fees, to Deposit Account 07-1337 and please credit any excess fees to such deposit account.

Respectfully submitted,

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